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Pre-Plan for the

NCAS Trans-Atlantic Saharan Dust AERosol and Ocean Science Expedition (AEROSE) aboard the NOAA Ship *Ronald H. Brown*

Pablo Clemente-Colón
NOAA/NESDIS/ORA

The NOAA Center for Atmospheric Sciences (NCAS) led by Howard University (HU) was granted the use of the NOAA Ship *Ronald H. Brown* to conduct a Trans-Atlantic Saharan Dust Characterization Experiment in 2004, RB-04-02. The fundamental purpose of this mission is to study the impacts and microphysical evolution of Saharan dust aerosol as it is transported across the Atlantic Ocean. The mission encompasses both, atmospheric and oceanographic components. In addition to HU, the cruise includes the participation of the University of Puerto Rico at Mayagüez (UPRM), the Canary Institute of Marine Sciences (ICCM), the Spanish Institute of Oceanography (IEO), the Laboratory of Atmospheric Physics Siméon Fongang (LPASF) in Dakar, the University of Miami Rosenstiel School of Marine and Atmospheric Science (RSMAS), the University of Washington Applied Physics Laboratory (UW/APL), NASA Goddard Space Flight Center (GSFC), NASA Jet Propulsion Laboratory (JPL) and NOAA/NESDIS/ORA. The cruise allocation is for a total of 27 days at sea and is scheduled to start on February 29, 2004 in Bridgetown, Barbados and end in San Juan, Puerto Rico on March 26 with a stopover at Las Palmas, Gran Canaria.

A. Goal

The primary mission of the NCAS Trans-Atlantic Saharan Dust AERosol and Ocean Science Expedition (AEROSE) 2004 cruise is to provide a set of critical measurements to characterize the impacts and microphysical evolution of Saharan dust aerosol transport across the Atlantic Ocean. Global transport of dust has been acknowledged as a significant factor in atmospheric radiative balance, atmospheric oxidizing capacity, the deposition of limiting nutrients into the upper ocean, transport of fungi and microorganisms, and in the indirect aerosol effect via cloud modification. The presence of dust aerosol as a significant factor in the remote sensing observation of both ocean and atmospheric parameters is also addressed.

Complementing the atmospheric and aerosol measurements, the cruise supports the collection of bio-optics and oceanographic observations including water sampling, spectroradiometry, and continuous in-water optical measurements. These observations will be used to study the effect of the dust on the marine boundary layer, characterize water masses throughout the transects, as well as to investigate upwelling conditions off the Northwest coast of Africa.

NESDIS/ORA is conducting additional and complementary *in-situ* and remote sensing activities that will support the validation and improvement of AVHRR SST corrections under tropospheric aerosol conditions using visible and IR data, the validation of MODIS aerosol and ocean data and products, the validation of AIRS soundings, the potential validation of ICESat aerosol observations, an investigation into the use of GhostNEt buoys in the detection of ocean surface features by SAR. We are also exploring the possibility of coordinated photographic observations from the International Space Station (ISS) during the cruise.

B. Cruise Management

Pablo Clemente-Colón, NESDIS/ORA - Chief Scientist: NCAS and NWS Office of Science and Technology asked Pablo Clemente-Colón to provide overall coordination and serve as Chief Scientist during this mission given his established professional relation as a NOAA scientist with the major participants. Dr. Clemente-Colón is a member of the NCAS Advisory Committee and has already led an aerosol and oceanographic field campaign in collaboration with ICCM off the Northwest African Coast. In addition to the coordination of the mission components, he will serve as the Remote Sensing Lead aboard.

Vernon Morris, HU/NCAS – Chief Experimenter and Primary Mission PI: Vernon Morris is the lead the lead experimenter and the PI for the main Saharan Dust Characterization Experiment aerosols & radiation studies.

Roy Armstrong, UPRM/NCAS – Bio-optical Oceanography Group Leader: Roy Armstrong will serve as leader for the bio-optics and oceanographic field activities, including spectroradiometry and in-water optical measurements.

Nick Nalli, NESDIS/ORA – SST Lead: Nick Nalli will serve as the leader for sea surface temperature (SST) and aerosol atmospheric corrections.

C. Cruise Route and Highlights

The proposed route is a result of several conversations that have been held to distill the optimum cruise track for both atmospheric and oceanographic science.

Ports of call: (1) Bridgetown, Barbados, (2) Las Palmas, Gran Canaria, (3) San Juan, PR

The cruise will originate from Bridgetown, Barbados and move south-southeast to a first "dry run" station at about 11° N 53° 55´ W. From this point the heading will be east-northeast along the trajectory indicated by the dust plume satellite climatology or the near real-time observations acquired aboard and continuing in the general direction of Dakar, Senegal (14:45^{o}N, 17:30^{o}W). The ship will then travel northwest along the coast of Africa to Las Palmas, Gran Canaria, Spain (28.15^{o}N, 15.40^{o}W). There will be at least 5 oceanographic stations along the cruise averaging four hours per station. This is sufficient time for the planned casts of 500 meters. Continuous atmospheric and oceanographic observations will be acquired throughout the transects. Routine deployment of atmospheric sondes (radisosondes and ozonesondes), ocean probes (XBT and XCTD), and drifting buoys will also be carried out. There will be an exchange of scientists and students in Gran Canaria for the second trans-Atlantic leg to San Juan, PR. At least two graduate courses will be offer throughout the cruise for registered and unregistered NCAS and Cooperative Remote Sensing Science & Technology Center (CREST) students.

The total time for the cruise is twenty-seven (27) days at an average cruise speed of 12.5 knots. Additional in port time in San Juan has been requested for an open house and other protocol activities between NOAA, UPRM, and IEO. In addition to the *Ronald H. Brown* 2004 allocation, a follow-up cruise is also in the draft allocation plan for June 2005. This collaboration may also lead to an opportunity to perform additional measurements aboard research vessels in the Spanish oceanographic fleet in 2005 and beyond.

D. Main NCAS Mission: Atmospheric Component: Characterization of the Microphysical and Chemical Evolution of Saharan Dust Aerosol Properties during Trans-Atlantic Transport – Vernon Morris and Everette Joseph, HU

Global transport of dust has been acknowledged as a significant factor in atmospheric radiative balance, atmospheric oxidizing capacity, the deposition of limiting nutrients into the upper ocean, transport of fungi and microorganisms, and in the indirect aerosol effect via cloud modification. The fundamental purpose of this mission is to provide a set of critical measurements to characterize the impacts and microphysical evolution of Saharan dust aerosol transport across the Atlantic Ocean.

The three primary scientific objectives of the proposed cruise are:

Objective 1: To characterize and quantify the microphysical evolution of the Saharan dust during transport. During the eastbound leg of the cruise we will measure and sample aerosol of successively younger "age" as we move into the dust plume. Conversely, we will sample and characterize continuously "aged" dust aerosols during the return (westbound) leg. Comparing the analyses of these samples and measurements will allow us to examine the chemical and microphysical evolution of the dust during transport.

The particular activities will focus on but not be limited to:

a. Measurement of aerosol optical properties along the ship track within and outside of dust plumes. These will be sun photometer measurements of aerosol optical thickness (AOT), column O_3 and column H_2O, at eight wavelengths. (HU, UPRM)

b. Measurements of air chemistry along the ship track within and outside of dust and smoke plumes. These will include ozonesondes, and in-situ measurements of carbon monoxide, ozone. (HU, NOAA-ARL)
c. Characterization of aerosol morphology in both unperturbed and dust-impacted air masses using both filter and quartz crystal microbalance (QCM) aerosol sampling. (HU)
d. Measurement of aerosol size and number densities in both unperturbed and dust-impacted air masses using a laser particle counter and QCM cascade impactors. (HU)
e. Measurement of condensation nuclei profiles in both unperturbed and dust-impacted air masses using a DMA/CNC system. (HU)
f. Characterization of the aerosol chemistry along the ship tracks. At minimum, this will involve QCM sampling, aerosol filter sampling, with chemical analysis of the samples performed post-cruise. (HU, NASA-GSFC, NOAA-ARL)
g. Gravimetric filter measurements of PM 2.5 and PM 10 for trace metal and microbiological analyses (UPRM and the Medical Sciences Campus (UPR)).

Due to the time of year and the airflow climatology of the eastern Atlantic, there is a strong possibility that we may encounter air masses that possess a combination of dust and smoke. We will treat any such encounters as an opportunity for value-added science and extend our measurements to these systems as well. We will need the support of NOAA-NWS and NOAA-ARL for trajectory modeling and meteorological analyses. We anticipate heavy use of the HySplit model for air mass trajectory analysis. This will be critical for characterizing air mass mixing, air mass history, and forecasting of the movement of the dust and smoke plumes.

The climatology of Saharan dust transport suggests that we should be able to sample a dust plume for a significant portion of the forward leg of the mission. We should encounter relatively unmixed dust plumes during the latter portion of the forward leg (last ~400 miles) and potentially during the early portion of the return leg. Depending on the local meteorology and burning activity, the probability of interacting with a smoke plume originating from West Africa during the forward leg will increase as we progress south-southwest of 10^{o}N along the ship track.

In the event that we encounter a significantly mixed plume (dust and smoke) we will attempt to characterize the chemistry of the plume, the size and chemical fractionation of the aerosols, and the radiative forcing in the marine boundary layer. The latter measurements will be compared to observations from satellite overpasses, to in-situ observations in unmixed dust plumes and in measurements of unperturbed marine air.

Satellite observations of the smoke plume transport indicate that a significant amount of the smoke is lost between 15^{o} and 35^{o}W. We will make observations along the entire transect to characterize smoke aerosol loss in this region. We also plan to perform up to ten ozonesonde launches, primarily in mixed plume instances. The purpose of these “opportunistic activities” is to investigate ozone loss processes in the different plume types. The ozonesonde launches are not part of the primary science of this mission, but can provide added-value for implications of the mixing of biomasss burning plumes with dust. .

Objective 2: To observe impacts of Saharan dust on the regional atmosphere with focus on the cloud properties and atmospheric radiative balance along the ship track. The atmospheric radiation experiments are designed to complement the boundary-layer aerosol microphysics and deposition measurement provide a link to model calculations of radiative forcing, and cloud indirect effects. The column measurements may also enable a clarification of partitioning of dust and smoke aerosols above the marine boundary layer. Instrumental techniques will involve both passive and active sensors but the central focus will be to obtain total column aerosol and cloud microphysics within the dust, smoke, and mixed plumes. Spectral irradiance measurements of the dust using the HU rotating shadow-band spectroradiometer (RSS) can also be compared to satellite measurements of aerosol and cloud properties.

Based on discussions to date, the following measurements and participants are anticipated: cloud optical properties – HU, radiative properties HU and NOAA-ARL, column atmospheric water profiles – NASA – GSFC, column aerosol profiles – NASA – GSFC, and satellite data analysis – NOAA-NESDIS.

Objective 3: To quantify the effect of the dust on the marine boundary layer.

a. Deposition rates of the Saharan dust aerosol to the ocean surface will be measured using mass flux determination techniques. These measurements will be coupled with direct sampling and characterization of ocean biogeochemistry below the dust plume. Several types of biogeochemistry experiments will be performed during the eastbound (return) leg of the mission in order to explore the effects of dust deposition on production and respiration in the marine boundary layer and shallow depths, nitrogen fixation via measurement of Trichodesmium activity, and characterization of the genetic library.
b. Impacts on ocean optical properties (UPRM) will be examined through two types of measurements. The apparent optical properties (aerosol direct effects) and inherent optical properties will be determined using a suite of submersible radiometers capable of measuring profiles of upwelling and downwelling radiation, and optical depth in the ocean. These observations along with measurements of biogeochemical rates (P/R) will allow estimation of the indirect effects (i.e. fertilization) of the aerosol on inherent optical properties of near surface waters.
c. Enrichment Experiments will be performed during the latter portion of the eastward leg and early portions of the westbound leg of the mission in order to characterize the biodiversity in the upper ocean as a function of dust deposition.
d. Iron and other trace metals will be measured in the water (ICCM) and incorporated in phytoplankton cells (UPRM).
e. Subtropical underwater (SUW) experiments to characterize the magnitude and spatial distribution of physical, chemical, and biological pools and process rates near the mid-Atlantic trough (~10^{o}N, 37^{o}W) during the westbound leg of the mission.

E. Oceanographic Component: Influence of Aerosol Deposition on Biogeochemical Processes in the Equatorial Atlantic – Roy A. Armstrong and Jorge E. Corredor, UPRM

Deposition of iron and inorganic nutrients from atmospheric aerosols is thought to modulate biogeochemical processes in the ocean by fertilizing surface waters enhancing planktonic biogeochemical processes including diazotrophy, primary production and respiration. Such enhancement may thus modulate air-sea C flux by increasing the rate of organic particle sinking to the deep ocean.

In conjunction with efforts to characterize the dust plumes emanating from the African continent during the *Ronald H. Brown* Expedition, we seek to assess these processes in near-surface waters of the tropical Atlantic by examining cell quotas of Fe, C, N and P and quantifying the photosynthetic competence of phytoplankton, their rates of C and N fixation and plankton respiration rates. We propose to assess these processes along a gradient traversing the oligotrophic subtropical North Atlantic gyre into the equatorial upwelling and across the area of influence of the Sahara dust plumes. Cell quotas for Fe, C, N and P will be measured in filtered samples along the cruise track. Photosynthetic competence will be determined by Fast Repetition Rate Fluorometry (FRRF). C-fixation will be measured using a ^{14}C tracer through "photosynthetron" incubation for the derivation of P vs I curves. N-fixation will be assessed as the capacity for acetylene reduction and phytoplankton respiratory capacity will be assessed using cell-free electron-transport activity assays.

The FRRF will be mounted aboard a Chelsea Nu-shuttle underwater undulating vehicle, also equipped with CTD, Chlorophyll fluorometer, oxygen optode, phycoerythrin fluorometer, Photosynthetically Active Radiation (PAR) and bioluminescence sensors. The vehicle will be towed at cruising speed undulating to depths of 80 m. At oceanographic stations, we will deploy a CTD/rosette, a Sequoia Scientific LISST-100 (laser transmisometer) an optical package for inherent optical properties incorporating a WetLabs AC-9, SBE CTD, Hobbie-Labs Hydroscat 6, Satlantic OCR radiometers and a Biospherical Instruments PRR600 profiling reflectance radiometer operating at SeaWiFS bands. Maximum cast depth will be 500 m for the CTD/rosette. Optical casts will be to depths of 100 to 200 m.

Complementary to the above studies, bacterial growth assays and collections for development of a genetic library will provide the basis for further studies related to microbial biodiversity within different provinces of different nutritional status. Leucine incorporation and growth curves will be conducted at selected oceanographic stations. Growth assays of microbial oligotrophs in dialysis bags will provide opportunities for culturing and identification of these diverse but mostly unknown species. Overall, this effort will allow the assessment of the meaning and/or contribution of oceanographic and atmospheric conditions to microbial growth. In addition, microbial cells will be concentrated from large volumes of water (+80L) by tangential flow filtration (TFF). From these cell concentrates, nuclear material will be extracted and preserved for later examination by molecular approaches

F. SST and Remote Sensing –Nicholas Nally and Pablo Clemente-Colón, NESDIS/ORA

NESDIS/ORA Oceanographic Research and Application Division (ORAD), also known as the Satellite Oceanography Division (SOD) is providing scientific expertise for this cruise in the areas of Sea Surface Temperature (SST) retrieval, analysis and radiative transfer modeling, and remote sensing through SST Team shipboard participants Nicholas Nalli (SST Team Lead) and Pablo Clemente-Colón (Chief Scientist, Remote Ssensing Lead). Shoreside SST support at NESDIS will be provided throughout the cruise by Andy Harris. ORAD is collaborating with Andy Jessup, UW/APL, in the operation of the shipboard Calibrated InfraRed In situ Measurement System (CIRIMS) instrument recently installed onboard the *Ronald H. Brown*, to acquire skin and bulk temperature observations. ORAD is also collaborating with Peter Minnett, RSMAS, to bring aboard the Marine-Atmosphere Emitted Radiance Interferometer (M-AERI) instrument to acquire hyperspectral IR observations of atmosphere, ocean and radiometric skin temperature. Sasha Ignatov, ORA Climate Research and Applications Division (CRAD), will be providing shoreside satellite aerosol optical depth (AOD) retrieval and data analysis at NESDIS throughout the cruise. Chris Barnet and Walter Wolf, CRAD, will provide shoreside soundings support. ORAD is also collaborating with NCAS to identify outside funds to supplement the limited ozonesondes and radiosondes available for the cruise. The NASA Atmospheric Infrared Sounder (AIRS) Team has already indicated interest in the cruise and in contributing additional ozonesondes. A request from the AIRS Team to the NASA Program Manager for radiosonde funding was also made. The intention is to try to provide sufficient radiosondes to make a launch every 3 hours throughout the cruise.

Through CRAD, collaboration has been established with the NASA MODIS CAL/VAL Team to support sunphotometer measurements and instrumentation pre- and post-calibration. ORAD has received additional indications from the University of Arizona (UA) that in lieu of refurbishing the NESDIS/ORA sunphotometer they are willing to provide additional land sunphotometers for deployment in the Caribbean in support of the experiment.

ORAD is coordinating with ICCM for the provision of XBTs for regular drops to complement UPRM CTD and underway scanfish ocean temperature vertical profiling. Also, coordination with ICCM and the NOAA/AOML Global Drifter Center is underway to deploy global Lagrangian drifting buoys during the cruise. The deployment of additional GhostNet buoys to detect and follow the seasonal migration of the subtropical convergence zone is under consideration in collaboration with William Pichel (Sea Surface Roughness Team Lead). If found, deployment on each side of the zone could provide information on the strength and longevity of the convergence in wintertime.

ACT will provide data management and intra-network connectivity for the cruise through the use of WIPE. Eric Malaret, ACT President, will be joining the cruise providing hands-on support. ORAD and NCAS are now closely collaborating with the *Ronald H. Brown* to try and maintain satellite data acquisition capabilities aboard the ship. A decision to remove the SeaSpace TeraScan system from the *Ronald H. Brown* was days away to be made by the time we had our first ship visit. This has been reconsidered after discussions on the importance of this capability to both atmospheric and oceanographic cruises, particularly since http access to other satellite data sources is no longer available. Software and hardware upgrade support as well as crew training are being explored. Sponsoring of the *Ronald H. Brown* TeraScan system by NESDIS has been suggested. Real time remote sensing acquisitions throughout the cruise will be used to guide and support the collection and analysis of both atmospheric and oceanic data. The study will use satellite and ground based measurements to track Saharan dust clouds. These can be followed using AVHRR HRPT data readily acquired onboard. The shipboard acquisitions will complement the very limited access to the Internet information and imagery available through INMARSAT.

ORAD ocean color activities aboard or at NESDIS during the cruise (Dennis Clark, Celso Barrientos and Chris Brown) have not been scoped out but may relate to the optical characterization of ocean water, the detection and position of the convergence chlorophyll fronts or the biological activity associated with dust iron enrichment or coastal upwelling.

G. Measure the inventory, sources and remineralization of organic carbon across the Atlantic Ocean – Antonio Mannino, NASA/GSFC (This piggyback mission tides-up with both the atmospheric and oceanographic components goals and efforts)

Dissolved organic matter (DOM) represents a dynamic component of the ocean that can vary due to impacts of global change on ecosystems. Because DOM represents a major component of the carbon cycle, studying the inventory, sources and removal of dissolved organic carbon (DOC) within the ocean is crucial to understanding the Earth system. Rivers/estuaries transport significant but not well-quantified amounts of terrestrial organic matter to the ocean. Deposition of aerosols and river/estuary borne material derived from biomass burning and fossil fuel combustion introduce black carbon (BC) to the ocean. Black carbon within the ocean's DOM pool represents an unknown carbon reservoir and potential carbon sink. The primary aim of this project is to quantify the variability of total and dissolved organic carbon, terrestrial and anthropogenic sources (lignin and black carbon) and sinks (microbial and sunlight-induced photochemical degradation) of DOM in the Atlantic and Pacific Ocean basins. Field sampling and experiments will be conducted on the Repeat Hydrography lines supporting the US CLIVAR and CO2 programs and other cruises of opportunity in coastal margins adjacent to the U.S. Total organic carbon (predominantly DOC in the ocean) is listed as a Level I core measurement for the CO2/CLIVAR hydrographic program. Experiments will be conducted to measure the microbial remineralization and sunlight-induced photochemical degradation of DOC to dissolved inorganic carbon. Exploring these issues will improve our models of the carbon cycle and help us better predict how natural processes and anthropogenic activity impact the ocean. Measurements include TOC, DOC, particulate organic carbon and nitrogen, Black carbon and lignin absorbance of DOM, detritus and phytoplankton fluorescence of DOM, and HPLC pigments in-water or above-water radiance measurements.

H. Water Chemistry Analysis and In-Port Support - Octavio Llinás González, IEO and Joaquín Hernández Brito, ICCM

Spain, through ICCM and IEO, is providing logistical support and personnel to 1) add yellow substance and aluminum water analysis at each station and every 3 to 5 hours throughout the cruise, 2) assist in the water sample collection effort and provide additional spectrofluorometer capabilities to the oceanographic component, 3) supplement the analysis of Chl-a, nutrients, and salinity, 4) provide additional XBT and XCTD units for upwelling research along the Northwest Africa coast and water mass distribution across the Atlantic during the return leg from Las Palmas to San Juan, 5) coordinate and conduct additional *in-situ* sunphotometer and aerosol observations in Gran Canaria during the cruise time frame, 6) provide post-cruise analysis of in-situ and remote sensing data, 7) assist in obtaining port clearances in Las Palmas de Gran Canaria and 8) coordinate cross-CAL/Val observation experiments and educational activities (student visits, seminars, and an open-house) while in port in Las Palmas.

I. - Marine Mammal Observation Project – Wendy L. Ryan, Kutztown University of Pennsylvania

Purpose: The focus of this study will be to generate an overview of cetaceans present in tropical Atlantic waters at the end of March. The data collected will provide information on the frequency of occurrence, abundance, density, and diversity of cetacean species in this region. In addition, efforts will be made to document signs of human impact on the animals observed. This data may be useful in clarifying the conservation status or success of various cetacean species, in particular the larger whale species that overwinter in this region.

Project Goals:
Document the frequency and abundance of cetaceans along the cruise transect from Las Palmas, Gran Canaria (27 ° 41.79’ N, 17 ° 10.74’ W) to San Juan, Puerto Rico (18 ° 401.71’ N, 66 ° 12.56’ W)

Use these data to determine the density of cetaceans within the survey area. Note: the extent of the survey area will depend on the number of observers and their visual range, plus the sampling effort.

Combine these data with positional information and geomorphology to determine distribution with respect to different oceanographic regions along the cruise transect, including shallow coastal areas, eastern versus western ocean margins, and the tropical open ocean.

Assess the potential correlations between frequency, density, and/or species abundance with data available from the *Ronald H. Brown*, including positional information/navigation, physical oceanographic data including surface water temperature and surface water salinity, and biological oceanographic data including chlorophyll a concentrations and the presence/absence of fish in the area of a sighting.

Estimate the species diversity of cetaceans along the cruise transect from Las Palmas, Gran Canaria (27 ° 41.79' N, 17 ° 10.74' W) to San Juan, Puerto Rico (18 ° 401.71' N, 66 ° 12.56' W)

Use these data to compare the frequency and distribution of odontocete versus mysticete whales, which roughly corresponds to a comparison between non-migratory versus seasonally migratory cetacean species.

Combine species diversity data with positional information and geomorphology to determine distribution of different species with respect to different oceanographic regions as described above.

Assess the potential correlation between species diversity and data available from the *Ronald Brown*, as described above.

Record the presence of any additional vessels or other obvious signs of human impact during all cetacean sightings.

Methodology: The observer(s) will collect data on an established rotation of 2 h observation, followed by a 30 min break. Observations will occur throughout the day when sufficient light is available. Observations will be halted if weather or sea conditions significantly impair the observers' sight. Observations may also be halted during the deployment and retrieval of equipment. The area surveyed will depend on the type of equipment (binoculars) available and the number of observers.
Data from various sensors on the *Ronald Brown* will be downloaded onto a laptop and integrated with the observational data to support the various analyses.

Appendix I - Cruise Shipboard Participants

Name	Affiliation	Scientific Responsibility
Armstrong, Roy A., Dr.	*UPRM/NCAS*	*Bio-optics & Oceanographic Measurements Lead*
Barrera Rodriguez, Carlos, Mr.	*ICCM*	*Ocean Water Sampling*
Brahma, Priti P., Dr.	*NWS/OST*	*Atmospheric Science*
Cabrera Rodríguez, Alvaro, Mr.	*UPRM*	*N-fixation*
Canals Silander, Miguel F.	*UPRM*	*Bio-optics*
Cianca Aguilar, Andrés, Dr.	*ICCM*	*Ocean Water Sampling*
Clemente-Colón, Pablo, Dr.	*NOAA/NESDIS*	*Chief Scientist & Remote Sensing Lead*
Corredor, Jorge E., Dr.	*UPRM*	*Fe, C, N, & P cell quotas, N-fixation*
Detrés, Yasmín, Dr.	*UPRM/NCAS*	*Aerosols & radiation*
García-Moliner, Graciela E., Ms.	*UPRM/NCAS*	*Bio-optics*
Godoy Delgado, Juana M., Ms.	*ICCM*	*Ocean Water Sampling*
Joseph, Everette, Dr.	*HU/NCAS*	*Atmospheric Radiation, Sonde Launches*
Justiniano Santos, Aurora, Ms.	*UPRM*	*FRRF, C-fixation*
Lopez Diaz, José M., Dr.	*UPRM*	*FRRF, C-fixation*
López-Rosado, Ramón	*UPRM*	*FRRF, C-fixation*
Lozada Rosado, Ana R., Ms.	*UPRM*	*Fe, C, N, & P Cell Quotas*
Malaret, Erick, Dr.	*ACT*	*WIPE Data Management*
Mannino, Antonio, Dr.	*NASA GSFC*	*Black Carbon Aerosol*
Méndez Silvagnoli, Marla M., Ms.	*UPRM*	*Aerosols, Enrichment Experiments Sampling*
Mensah, Francis Emmanuel, Mr.	*HU/NCAS*	*Atmospheric Radiation, Sonde Launches*
Morales-Irizarry, E. Veronica, Ms.	*UPRM/CREST*	*Aerosol Observations*
Morell, Julio M., Prof.	*UPRM*	*ETS, N-fixation*
Morris, Vernon R., Dr.	*HU/NCAS*	*Primary Mission PI/Chief Experimenter, Saharan Dust Aerosols & Radiation*
Muñoz, Milton F., Mr.	*UPRM*	*ETS*
Nalli, Nicholas, Dr.	*NESDIS/ORA*	*SST/Remote Sensing of Aerosols*
Otero Morales, Ernesto, Dr.	*UPRM*	*Microbial Growth & Genetic Library Development*
Pérez Marrero, Javier , Dr.	*ICCM*	*Ocean Water Sampling*
Roldán, Lizette, Ms.	*HU/NCAS*	*Aerosols*
Rueda López, María J., Dr.	*ICCM*	*Ocean Chemistry*
Ryan, Wendy, Dr.	*KU/MSC*	Marine Mammal Watch
Sánchez, Ahira, Ms.	*UPRM*	*Aerosols*
Sow, Bamol Ali, Mr	*LPASF*	*Aerosol Measurements*
Strachan, Michelle D., Mrs.	*HU/NCAS*	*Aerosols*
Szczodrak, Malgorzata, Dr.	*UM/RSMAS*	*M-AERI*
Toppin, Crystal, Ms.	*CUNY/CREST*	*Aerosols*
Villa García Úbeda, María Guadalupe Mar, Dr.	*ICCM*	*Ocean Water Sampling*
Williams, Heidi, Ms.	*MSC*	Marine Mammal Watch

Appendix II - Shoreside Participants

Name	Affiliation	Scientific Responsibility
Barnet, Chris, Dr.	*NESDIS/ORA*	*Atmospheric Soundings*
Barrientos, Celso S., Dr.	*NESDIS/ORA*	*Ocean Color*
Friedman, Karen S., Ms.	*NESDIS/ORA*	*GIS/Website*
Garcia Soto, Carlos, Dr.	*IEO*	*In-situ & R.S. analysis*
Gaye, Amadou Thierno, Dr.	*LPA*	*AERONET*
Harris, Andy, Dr.	*NESDIS/ORA*	*SST*
Hernandez-Brito, Joaquin, Dr.	*ICCM*	*Trace metals, Aerosols*
Ichoku, Charles	*NASA/GSFC*	*Sunphotometer CAL/VAL*
Ignatov, Alexander, Dr.	*NESDIS/ORA*	*Aerosol*
Jessup, Andrew, Dr.	*UW/ APL*	*Radiometric measurements*
Llinás González, Octavio, Dr.	*IEO*	*IEO Dir. - Water Sampling*
Minnett, Peter, Dr.	*UM/RSMAS*	*M-AERI*
Nzeffe, Fonya, Mr.	*HU/NCAS*	*Atmospheric Radiation*
Ondrusek, Michael, Mr.	*NESDIS/ORA*	*Bio-optics*
Pichel, William G., Mr	*NESDIS/ORA*	*SAR/GhostNet*
Wolf, Walter, Dr.	*NESDIS/ORA*	*Atmospheric Soundings*
Zhao, Xuepeng (Tom), Dr.	*NESDIS/ORA*	*Aerosol Validation*